Homi Bhabha Centre for Science Education (TIFR)

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One generally associates Tata Institute of Fundamental Research with its research schools in mathematics and physics at Mumbai. The scientific community in India is also aware of its work in radioastronomy, the radiotelescope at Ooty and its current major project of constructing a Giant Metrewave Radio Telescope near Pune. A National Centre of TIFR in Biological Sciences has also come up at Bangalore. Against this background, it is interesting to know that TIFR has also set up, with DAE assistance, a major National Centre devoted to science and mathematics education and popularization.

As with other offshoots of TIFR, this Centre, too, was not created as a planned initiative. It seems to have just happened. In the late 1960s, some scientists of TIFR began to feel concerned with the general state of science education in the country. A few of them started some programmes on a voluntary basis in the schools of Bombay Municipal Corporation. The activities grew rapidly and a strong need was felt for institutional support to carry out field projects systematically, conduct basic research in science education and bring out relevant educational materials. B. M. Udgaonkar and V. G. Kulkarni knocked at several doors for help but encountered apathy and indecision. Fortunately, the Sir Dorabjee Tata Trust agreed to support the activities and the Centre was founded in July 1974 as a project at TIFR. By 1981, the Centre had earned considerable reputation for the quality and relevance of its work and DAE undertook to support it fully as a unit of TIFR. A decade after its inception, with new staff members joining it, the Centre expanded its activities substantially on different fronts. In time, it got recognized as one of its National Centres under the School of Physics of TIFR. For eighteen years, the Centre had operated from a small wing of a Municipal School in Central Mumbai. Thanks to a generous DAE grant, an independent building was built for it at Anushaktinagar. The new campus to which it moved some four years ago has good infrastructure and facilities. A hostel is also coming up at its premises and is expected to be functional by the end of this year.

What strategies has the Centre adopted to make meaningful contributions to the difficult enterprise of science and mathematics education in India? Udgaonkar explains that from its inception the Centre decided to work at the school tier of education and focus on the remedial education of socio-economically disadvantaged students. In parallel with its work on municipal school children in Mumbai, it took up a project of improvement of middle school science teaching in the rural area around Khiroda in Maharashtra. The project involved orientation of teachers over a period of three years, extended school visits and monthly follow-up meetings. A low-cost laboratory kit was developed that continued to be evolved and used in the Centre's elementary school programmes since then.

Two among the several action research projects initiated by the Centre's founder Director (V. G. Kulkarni) in the 1980s are especially noteworthy. In one, linguistically simplified versions of middle school textbooks were prepared and tested on a large sample of municipal school children. The study apparently showed that a simple inexpensive step of using simplified language in the textbook (with no other reforms or changes in the curriculum) leads to considerable improvement. Students perform better, teacher–pupil interaction improves and, most importantly, the differential in performance of students from different socio-economic strata decreases. In another significant and important experiment lasting about six years (1980–86), the Centre worked on several batches of Scheduled Caste students from the municipal schools in Mumbai and demonstrated that it was possible to develop inexpensive and specific remedial measures in science and mathematics to improve the scholastic performance of these disadvantaged students, not marginally but substantially. Equipped with this confidence, the Centre undertook a number of large-scale collaborative projects with the Government of Maharashtra and with NGOs in different parts of the State. The projects involved teacher orientation or orientation of resource persons who in turn taught teachers. The positive results seen in the earlier pilot scale experiments got considerably diluted, as was to be expected since direct contact with students was not feasible. Yet the Centre gained rich field experience, especially with regard to the possible methodology for transferring its results when operating on a small scale, into the larger educational system. I believe few organizations in the country, and also Eklavya (in MP) and Kerala Shastra Sahitya Parishad, have such extensive experience of grassroots teaching of science and mathematics. Currently, the Centre is involved in yet another ambitious project that involves orientation of teachers of the network of residential tribal schools (ashram schools) in Maharashtra. Also, the Centre is trying to extend its activities beyond its local state. Its strategy for this purpose is to collaborate with national networks of schools such as those of the Atomic Energy Education Society, Bharatiya Vidya Bhavan, etc. In the past five years, a number of orientation programmes have been carried out as far as in Kalpakkam (Tamil Nadu), Hyderabad, Ravatbhata (Rajasthan), Jaduguda (Bihar) and Kodaikanal. The Centre is one of the few organizations in the country which has the wherewithal to carry out quality programmes of teacher orientation in science and mathematics up to senior secondary level.

An important plank of the Centre's activities is the development of remedial and enrichment books. Some of the books (published by the Oxford University Press) have been translated into several Indian languages. The books have not been professionally reviewed, and a major limitation of the effort is the virtual absence of a distribution network, which is the reason the Centre's work is not known in many places where it should be known. Since mathematics is a major cause of failure and alienation among the disadvantaged, the Centre has taken up remedial mathematics education as one of the thrusts of its activities. Considerable remedial materials in mathematics have been produced, though most of these remain to be translated from Marathi to other Indian languages. This effort is being led by a theoretical physicist, H. C. Pradhan, who, after a Ph D in

Nuclear Theory from MIT decided to turn completely to physics and mathematics education.

One important thing about HBCSE, Udgaonkar explains, is that it emphasized the content of science and mathematics as much as pedagogy. From the beginning, the Centre took care to see that the staff members it recruits are not mere pedagogues, but have reliable competence in their respective disciplines. After a decade of its work at the school level, the Centre decided to extend its activities to senior secondary and introductory college levels, and to bright students also. The current Director of the Centre (Arvind Kumar) who joined it in 1984, with a reputation as an excellent University teacher, initiated this activity in physics. A 'Homi Bhabha Study Circle' was started for motivated college students. The Circle emphasized problem-solving in physics that is sorely absent in normal college education. A large number of problems in senior secondary and undergraduate physics were designed, many of which found their way into the new NCERT textbooks in physics for classes XI and XII, which were developed mainly at Bangalore. After moving to the new campus in 1992, these efforts have been extended to other disciplines. New laboratories up to junior college level have come up in physics, chemistry and biology, and it is nice to see some of the innovative experiments that have been developed. The Centre has also begun to participate in the mathematical olympiad activities. It organized the International Mathematical Olympiad Training Camp at its premises this year and the last. From this year, the Centre has been assigned a key academic and organizational role in the physics olympiad activities. I was told that the Centre was looking for bright and motivated young mathematicians and physicists (and scientists in other areas too!) to join it and increase its participation in the olympiad activities. Arvind Kumar is excited about this new role the Centre is to play in the promotion of content excellence at a crucial stage of education.

A thing unique to the Centre is its interest from its inception in basic research in students' learning processes. This subject, now going by the name 'cognitive science' seems to have become the core intellectual area of the group. A number of staff members with varied backgrounds in psychology, sociology and philosophy are quite excited about this area which is probably pursued only at a few other places in the country. The Centre organized an International Workshop on Cognitive Bases of Learning in 1995 and the proceedings have been brought out by the National Centre for Software Technology. Its staff members have published considerable research in international journals devoted to this area. The connection of this area with actual practice of education may be somewhat far-fetched but they believe it is essential to develop expertise in this subject for ensuring quality of its work in the long run. On the other side of the coin, various field activities feed into the research in cognitive science.

Most of the activities mentioned above refer to the formal education sector. Udgaonkar says that from the beginning, the Centre had also been interested in popularization of science among the masses. In its early years, the Centre contributed to the *Satellite Instructional Television Programme*. It has also produced a package of easy-to-use folders for basic science literacy for the non-formal education stream. The Centre's staff continue to write expository articles/books on science and mathematics and a number of titles have been brought out over the years. For several years, the Centre operated a question–answer service. Any child could send a query to the Centre and expect to get the answer by post. Still the activity of the Centre on this front appears subcritical. One new direction the Centre has taken pertains to history of science. The Centre has assembled an impressive exhibition on this theme at its premises. In a span of some 32 panels, it summarizes milestones in science from its primitive beginnings to twentieth century science and there are future plans for bringing out a series of books on history of science and audio-visual materials on this theme for large-scale dissemination. This seems a nice idea, but is very difficult to implement.

Where would all these disparate activities converge to, and are they not spreading their efforts too thin? Arvind Kumar shares these fears but said that the Centre was now trying to operate in a mission mode, at least so far as the development of books and materials is concerned. The principal mission was to develop an alternative curriculum – Homi Bhabha curriculum – as they like to call it with some pride. One hopes the curriculum justifies the name, of one of our greatest physicists. This means developing alternative textbooks and collateral materials in school science and mathematics. The Centre has participated in textbook writing exercises at the National and State levels, but is not completely satisfied with it and wants to develop a pace-setting curriculum of its own, based on its field experience. The work on developing primary level curriculum is well under way. I thought the idea interesting but problematic. In the first place, who would want to adopt a curriculum that is outside the mainstream? Has the Centre adequately thought of its dovetailing with the current evaluation system? In spite of clarifications, many questions remained unanswered. Hopefully, the answers will be found as they go along.

Another project they have taken up is to develop a foundation curriculum beyond the school stage, a kind of issue-based science curriculum cutting across conventional disciplines of physics, chemistry, biology, etc. Once again I found the idea interesting but perhaps a little fanciful and ambitious to implement in practice.

The activities are a trifle too many for a Centre of the present size – about 25 members in all including the supporting scientific staff. (This does not include a substantial administrative staff.) No matter how competent and dedicated its faculty is, the quality and coherence of work are bound to suffer in course of time unless the Centre reduces its range of activities or greatly augments its staff. I was told that the Centre was going to have a strong visitors' programme as soon as its hostel comes up. This would enable teachers and scientists from different parts of the country to work at the Centre for extended periods of time. Still, worrying thoughts about the Centre's ultimate impact of its valuable work lingered in my mind as I left the charming and enthusiastic group of people who staff this institution.

India is a vast country with a diversity of languages, cultural traditions, and area-specific educational problems. On seeing what the HBCSE has been able to do, and is planning to do, one cannot but feel that if motivated scientists at other prestigious institutions in the country can be encouraged to undertake similar activities in the field of school/college education, it could help change the depressing educational scene in the not-too-distant a future.

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